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LCLS XTOD UHV Specifications

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LCLS XTOD UHV Specifications

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Change History Log

Rev No.	Revision Date	Sections Affected	Description of Change
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Auspices Statements

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1. Scope

1.1. This Engineering Specification Document (ESD) contains the Lawrence Livermore National Laboratory (LLNL) Mechanical Engineering Livermore (MEL) specifications that define the requirements and procedures for the fabrication, cleaning, assembly, leak checking, handling, and shipping of components intended for Ultrahigh Vacuum (UHV) applications for the LCLS XTOD. Components and systems intended for use in the LCLS XTOD must be vacuum-compatible with the entire LCLS accelerator complex, i.e. must not introduce contamination which might compromise operation of the facility. These MEL specifications provide standards and guidance for both LLNL in-house and external-vendor production of compatible vacuum instrumentation.

LLNL Documents (see Appendix for complete document)

1.2. MEL07-500001 Leak Checking Ultrahigh Vacuum Components

1.3. MEL07-500002 Fabrication, Cleaning, and Assembly/Handling of Components for use in an Ultrahigh Vacuum Environment

1.4. MEL07-500003 Welding of Stainless Steel Components for use in an Ultrahigh Vacuum Environment

1.5. MEL07-500004 Chemical Cleaning of 300 Series Stainless Steel for use in an Ultrahigh Vacuum Environment

1.6. MEL07-500005 Chemical Cleaning of Aluminum for use in an Ultrahigh Vacuum Environment

1.7. MEL07-500006 Chemical Cleaning of OFE Copper for use in an Ultrahigh Vacuum Environment

1.8. MEL07-500007 Chemical Etching of Titanium for use in an Ultrahigh Vacuum Environment

2. Drawing Notes

2.1. The drawings created by LLNL use the following drawing notes.

2.1.1. LEAK TESTING SHALL BE PERFORMED IN ACCORDANCE WITH MEL07-500001 (LEAK CHECKING ULTRAHIGH VACUUM COMPONENTS). MAXIMUM LEAK RATE SHALL BE LESS THAN $2x10^{-10}$ ATM CC/SEC. ANY DEVIATION FROM THIS SPECIFICATION SHALL BE SUBMITTED TO LLNL FOR APPROVAL.

2.1.2. FABRICATION AND HANDLING OF COMPONENTS SHALL CONFORM TO LLNL SPECIFICATION MEL07-500002 (FABRICATION, CLEANING, AND ASSEMBLY/HANDLING OF COMPONENTS FOR USE IN AN ULTRAHIGH VACUUM ENVIRONMENT). ANY DEVIATION FROM THIS SPECIFICATION SHALL BE SUBMITTED TO LLNL FOR APPROVAL.

2.1.3. INDICATED WELDS PER LLNL SPECIFICATION MEL07-500003 (WELDING OF STAINLESS STEEL COMPONENTS FOR USE IN AN ULTRAHIGH VACUUM ENVIRONMENT). ANY DEVIATION FROM THIS SPECIFICATION SHALL BE SUBMITTED TO LLNL FOR APPROVAL.

Appendix

The following pages contain the complete copies of the MEL Specifications.

MEL07-500001-AA

SPECIFICATION

University of California
Lawrence Livermore National Laboratory

Engineering Department
Applied Engineering Infrastructure Division

Title: **Leak Checking Ultrahigh Vacuum Components**	Author: Patrick Duffy	Date: 2-5-07
	Reviewer: Stewart Shen	Date: 2-5-07
	Approved: Donn McMahon	Date: 2-5-07

1. **Scope**
   1.1. This specification defines the requirements for leak checking ultrahigh vacuum components using a helium mass spectrometer leak detector.
2. **Reference Documents**
   2.1. American Society for Testing and Materials (ASTM)
      2.1.1. ASTM E498-95(2000) Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode.
3. **Requirements**
   3.1. The component shall be leak tested to determine conformance with the leak rate specified on the drawing or purchase order.
   3.2. For ultrahigh vacuum components and assemblies, it is crucial that the leak checking procedure not introduce hydrocarbon contamination. This is especially important when re-cleaning or a bakeout is not feasible.
      3.2.1. The leak detector vacuum pumps must be oil-free (dry) and compatible with testing cleaned ultrahigh vacuum components.
      3.2.2. No lubricants or greases of any kind may be used in obtaining the temporary seal required for the purpose of leak checking any component.
   3.3. Leak testing shall be performed in accordance with ASTM E498-95(2000), Test Method A. To determine conformance with the leak rate specified on the drawing, all gases must pass through the mass spectrometer vacuum circuit. No parallel pumping circuits or auxiliary pumps may be used.
   3.4. All test results shall be recorded, signed by an authorized representative of the vendor, and submitted to LLNL prior to delivery of the hardware.
   3.5. LLNL reserves the right to have an LLNL representative witness all testing. If called for in the purchase order, the vendor shall notify LLNL at least seven (7) working days prior to conducting the test.
   3.6. Prior to award of the contract, the vendor's facilities and capabilities may be subject to an inspection by an LLNL representative(s) to verify adequacy for performing work per this specification.
   3.7. If the vendor determines that the requirements in this specification are not practical, the vendor shall propose and submit an alternative specification to LLNL for review and approval.

SPECIFICATION

AAN07-100021-AA

University of California
Lawrence Livermore National Laboratory

Engineering Department
Applied Engineering Infrastructure Division

Title: **Fabrication, Cleaning, and Assembly/Handling of Components for use in an Ultrahigh Vacuum Environment**	Author: Patrick Duffy	Date: 3-28-07
	Reviewer: Stewart Shen	Date: 3/28/07
	Approved: Donn McMahon	Date: 4/2/07

Revision History
AA – Initial Release

Table of Contents

1. **Scope**
   1.1. This specification defines requirements and procedures for the fabrication, cleaning, assembly and handling of components intended for Ultrahigh Vacuum (UHV) applications. Extreme care is required to obtain clean components that will not introduce contamination at the end-use facility. This is a general specification and not all sections will necessarily apply to all drawings which refer to this specification.
2. **Reference Documents**
   2.1. Unless otherwise specified, the latest revision of the referenced documents is to be used. Any conflicts between this specification and the referenced documents shall be brought to the attention of LLNL in writing, for resolution before any action is taken by the vendor.
   2.2. American Society for Testing and Materials (ASTM)
      2.2.1. ASTM A380 Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
      2.2.2. ASTM B479 Standard Specification for Annealed Aluminum and Aluminum-Alloy Foil for Flexible Barrier, Food Contact, and Other Applications.
   2.3. Mechanical Engineering Livermore (MEL) Specifications
      2.3.1. MEL07-500004 Chemical Cleaning of 300 Series Stainless Steel for use in an Ultrahigh Vacuum Environment
      2.3.2. MEL07-500005 Chemical Cleaning of Aluminum for use in an Ultrahigh Vacuum Environment
      2.3.3. MEL07-500006 Chemical Cleaning of OFE Copper for use in an Ultrahigh Vacuum Environment
      2.3.4. MEL07-500007 Chemical Etching of Titanium for use in an Ultrahigh Vacuum Environment
3. **Fabrication Requirements**
   3.1. Unless supplied by LLNL, all material shall conform to the requirements stated on the drawing(s) or an appropriate ASTM Standard(s).
   3.2. No fabrication operations which might result in contaminates becoming embedded in the material shall be used, except as noted.
      3.2.1. Material may be roughed to size by machining, metal stamping, water-jet cutting, laser cutting, plasma arc cutting, and/or chemical etching/milling only. Use approved cutting fluids specified in Section 3.2.4 of this specification. Cleaning shall conform to Section 5.
         3.2.1.1. Thermal cutting of metals is permitted as a roughing operation for the purpose of cutting material to size prior to finishing operations. Sufficient material allowance shall be made for complete removal of the Heat Affected Zone (HAZ) during the finishing process. This region of altered metallic microstructure and properties varies in size depending upon the variety of thermal cutting operation employed and the specific parameters used.
         3.2.1.2. Bead and/or sand blasting is permitted only on material having large amounts of mill scale or heavy inclusions from contact with metallic or organic material. Blasting shall generally be done prior to the finishing step, except as outlined in Section 3.2.2.1.
      3.2.2. The preferred technique for finishing is by machining only. No abrasives or polishing compounds are to be used unless approved by LLNL. All commonly-available cutting tools are permitted. Metal removal other than by machining, such as grinding, honing, EDM, chemical milling, glass bead and/or sand blasting, etc. are not allowed, without approval from LLNL.
         3.2.2.1. Glass bead blasting will be permitted only when specifically authorized by LLNL. When permitted, new, clean glass beads must be used. The affected surfaces shall then be cleaned according to the appropriate material cleaning procedures, as outlined in Section 5.
         3.2.2.2. If the surface finish requirements cannot be met by machining alone, then polishing with approved abrasives, as specified in Table 2, is permitted. Care must be taken to avoid using excessive pressure during polishing so as to preclude contamination of surfaces by embedded abrasives. Avoid any

burnishing or discoloration due to heating from excessive rubbing and/or contact pressure.

3.2.3. Deburring is limited to the use of a file, deburring knife or permitted abrasives. Deburring by abrasive vibrating or tumbling is only permitted if the medium is silicon carbide in conjunction with approved fluids as specified in Section 3.2.4. All other methods are not allowed, without prior written permission from LLNL.

3.2.4. Fluids used in machining or polishing UHV components shall not contain sulfur or silicone compounds. Approved fluids are limited to those listed in Table 1. Any related Environmental Safety and Handling issues associated with their use are the responsibility of the vendor. The use of any other fluids shall be submitted to LLNL for review and approval.

Table 1 Approved Fluids

•150B Solvent (Penreco Corp.)	• S-500 CF (Hangsterfer's Laboratories)
•A-9 (Relton Corp.)	•Tap Magic (Steco Corp.)
•CIMCOOL CIMSTAR 40 (Milacron Inc.)	•Tapmatic No. 1 (LPS Laboratories)
•Man-852 Honing Oil (Sunnen Products Co.)	•Tapmatic No. 2 (LPS Laboratories)
•Micro-Drop "Advanced Synthetic Lubricant (Trico)	•Trim Sol (Master Chemical Corp)
•Micro-Drop "New Vegetable Based" (Trico)	•Trim Tap(Master Chemical Corp)
•Rapid Tap (Relton Corp.)	

3.2.5. Abrasives for use on UHV components are limited to those listed in Table 2. The use of any other types of abrasives shall be submitted to LLNL for review and approval.

Table 2 Approved Abrasives

3M™ Scotch-Brite™	Type S – Silicon Carbide (gray color) Type A – Aluminum Oxide (maroon color)
3M™ Wetordry™ Fabricut™	Aluminum Oxide
3M™ Wetordry™ Tri-M-ite™	Silicon Carbide

4. Special Requirements

4.1. Examine all knife-edge flanges for defects in the knife edge prior to any of the above processes. Return all flanges having a knife edge defect. The knife edge of a flange must be covered at all times, unless a fabrication process precludes this from happening. (Care shall be taken to protect the knife edge even during such processes.) Once the process is completed, protection of the knife edge shall resume. Minimal protection requires a copper gasket be secured in some fashion so protection is achieved. Flanges delivered with knife-edge defects will be rejected.

4.2. Refer to LLNL drawings for specific process requirements for brazing or welding.

4.3. Unless otherwise specified, furnace firing for stress relieving, annealing, brazing, clean firing or any other furnace process shall be performed in a hydrogen or inert atmosphere. Refer to LLNL drawings for specific process requirements and temperature ranges.

4.4. When vacuum furnaces are required for an operation, the furnace must be hydrocarbon-free and may be used only with prior approval of LLNL. Refer to LLNL drawings for specific process requirements and temperature ranges.

5. Cleaning Requirements

5.1. Surfaces that will be subject to UHV shall be chemically cleaned of all foreign materials, such as, but not limited to, oil, grease, dust, and oxides or sulfides resulting from chemical reaction of the surface. Cleaning shall at a minimum conform to ASTM A380 and be adequate to remove all visible evidence of contamination, including stains or discoloration of the surface, unless otherwise specified. Cleanliness shall be maintained throughout subsequent processing and handling.

5.1.1. All components shall be cleaned in accordance with the following recommended procedures. Any deviations from these recommended procedures shall be submitted to LLNL for approval per Section 5.1.2.

5.1.1.1. MEL07-500004 Chemical Cleaning of 300 Series Stainless Steel for use in an Ultrahigh Vacuum Environment

5.1.1.2. MEL07-500005 Chemical Cleaning of Aluminum for use in an Ultrahigh Vacuum Environment
5.1.1.3. MEL07-500006 Chemical Cleaning of OFE Copper for use in an Ultrahigh Vacuum Environment
5.1.1.4. MEL07-500007 Chemical Etching of Titanium for use in an Ultrahigh Vacuum Environment
5.1.2. Alternative cleaning procedures shall be submitted to LLNL for approval and are to include a description of the cleaning process, type and grade of cleaning fluids, and procedures for maintaining cleanliness during processing and handling.
5.1.3. Electropolishing of final components shall be done in accordance with procedures outlined on the LLNL drawings or purchase order. Any deviation from these procedures shall be submitted to LLNL for approval.

6. Assembly and Handling Requirements

6.1. The following are recommended procedures for the proper assembly and handling of cleaned components. These steps are crucial to insure the success of the end-use application.
6.1.1. Assembly shall take place in a closed room or designated area specifically prepared as a **CLEAN AREA** per Section 6.1.3. Any deviations from these recommended procedures shall be submitted to LLNL for approval per Section 6.1.2.
6.1.2. The vendor's assembly/handling procedures shall be submitted to LLNL for review and approval. Included shall be a detailed description of handling and cleanliness procedures for ordered components. LLNL review will determine compatibility with the end-use.
6.1.3. The following **CLEAN AREA** procedures are presented as a guideline that, when combined with good judgment and skill, will produce clean ultrahigh vacuum components.
6.1.3.1. A positive pressure, filtered air, ventilation system shall be provided to prevent intrusion of airborne particles and/or fume contamination in the **CLEAN AREA**. A level or class of particle count will be specified on the drawing or purchase order, if required.
6.1.3.2. No food, drinks, or smoking are allowed and a notice stating this shall be posted at all **CLEAN AREA** entrances.
6.1.3.3. Limit **CLEAN AREA** entry. Sticky mats shall be used at each entry point and changed as required.
6.1.3.4. Wear clean-area-quality protective clothing (e.g. - Dupont® Tyvek™ Cleanroom Garments) when working in a designated **CLEAN AREA**. This includes coveralls, head cover, beard/face cover, shoe covers. No woolly sweaters are allowed. Hands must be kept out of pockets as this produces free-floating lint.
6.1.3.5. Clean parts and tools shall only be handled using new, lint-free, powder-free, clean-room gloves. Hands shall be washed before putting on gloves.
6.1.3.6. Replace clean gloves with a new pair at the beginning of each shift and following breaks.
6.1.3.7. Gloved hands which touch cleaned parts and tools must touch nothing else. Gloves which come in contact with unclean surfaces (face, clothing, bench, chairs, and so on) shall be immediately replaced with a new pair.
6.1.3.8. Hydrocarbons (e.g. - oil and grease) or dust-generating materials (e.g. – cardboard) shall be minimized in the **CLEAN AREA.**
6.1.3.9. Wood in the **CLEAN AREA** must be minimized.
6.1.3.10. High-grade ethanol (190 proof ethyl alcohol) is the only solvent allowed in the **CLEAN AREA.**

6.1.3.11. Aluminum foil for use in the **CLEAN AREA** shall be in accordance with ASTM B479 and of the type designated as DRY ANNEALED, A (oil free), UHV aluminum foil[1]. Each piece of aluminum foil is to be used only once and must be discarded after use. Foil must be stored in clean boxes. The lids on these boxes shall be kept closed when the foil is not in use.

6.1.3.12. Lint-free tissue shall be stored in clean boxes. The lids on these boxes shall be kept closed when not in use.

6.1.3.13. Clean parts and vacuum chamber openings shall be covered with clean aluminum foil, clean-area-quality bags, or clean lint-free wipes, at all times when work is not being performed.

6.1.3.14. A special set of tools, expressly for the construction of vacuum components, shall be set up in the **CLEAN AREA**. Tools for **CLEAN AREA** use should not leave the **CLEAN AREA**. Only chrome or nickel-plated tools are allowed. No cadmium plated, lead, or painted tools or materials are permitted. All tools shall be degreased with acetone followed by high-grade ethanol (190 proof ethyl alcohol). After degreasing, the tools shall be kept in clean trays in the **CLEAN AREA** and be handled with clean gloves. When not in use, the clean tools shall be covered with UHV aluminum foil. When assembly or repair of a subsystem is to begin, the tools anticipated for use in the work shall be re-cleaned before work begins. In addition, the entire toolset shall be cleaned every three months.

6.1.3.15. Equipment brought into the **CLEAN AREA** must be cleaned prior to entry. Carts, stands, tools, fixtures and other equipment must not be oily, greasy, dirty, or dusty and must be blown off with clean, oil-free compressed air or wiped down with appropriate cleaning solutions immediately prior to their entry into the **CLEAN AREA**. Note that all wheels on any equipment must also be cleaned prior to entry.

6.1.3.16. Only ink pens are to be used for writing in the **CLEAN AREA**. Do not use pencils or printers of any kind. Do not bring unnecessary paper into the **CLEAN AREA**.

6.1.3.17. No abrasives are allowed in the **CLEAN AREA**.

6.1.3.18. **NOTE:** PVC (polyvinylchloride) plastic containing dioctylphalate (a plastizer) shall not be used during handling or packaging of UHV components, as contamination will occur.

7. Inspection and Testing Requirements

7.1. The vendor shall be responsible for inspection and testing to assure that the product delivered conforms to requirements on the drawings, purchase order, and this specification.

7.2. Prior to award of the contract, the vendor's facilities and capabilities may be subject to an inspection by an LLNL representative(s) to verify adequacy for performing work per this specification.

7.3. Upon request, all records of material acquisition, manufacturing, and Quality Assurance (QA) shall be made available to LLNL.

7.4. All parts shall be inspected by LLNL for compliance with this specification and the documents referenced herein. LLNL reserves the right to conduct this inspection at the vendor's site prior to shipment.

8. Shipping and Delivery Requirements

8.1. The vendor shall clean and package the item(s) to maintain cleanliness and to prevent damage during handling and shipment to the site specified on the purchase order. All components are to be prepared and handled in accordance with Section 6, Assembly and Handling Requirements.

8.2. The vendor's packaging and shipping procedures shall be submitted to LLNL for review and approval.

8.3. Handling procedures from Section 6.1.3.4 and 6.1.3.5 are recommended and that each component is individually-wrapped with lint-free tissue and the UHV aluminum foil specified in Section 6.1.3.11.

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[1] Product of All-Foils, Inc., Cleveland, OH

8.4. Shipping containers shall be marked to indicate the following:
- 8.4.1. LLNL Purchase Order Number (**P.O.**)
- 8.4.2. **LLNL Contact** as specified on the **P.O.**
- 8.4.3. Shipping Address as specified on the purchase order, including the building number, room number, and L-Code
- 8.4.4. Packing List
- 8.4.5. Vendor's name and address
- 8.4.6. Apply the appropriate warning sticker(s) to the shipping container (e.g. - THIS SIDE UP, FRAGILE, etc.)
- 8.4.7. Apply a **DO NOT OPEN** label as shown below in Figure 1. Minimum of one per side and one on the top of the shipping container.

DO NOT OPEN

ULTRAHIGH VACUUM COMPONENTS

CALL
(LLNL CONTACT from P.O.)
FOR INSTRUCTIONS

SPECIAL HANDLING REQUIRED

Figure 1

9. **Documentation Requirements**

9.1. The vendor shall furnish the following documentation for LLNL approval or information, in accordance with the referenced sections of this specification, at the times shown in Table 3. LLNL review of drawings, data, specifications, or procedures submitted by the vendor does not constitute acceptance of any design, materials, process, or components which do not fulfill the requirements of this specification. Written permission to the vendor prior to any change or deviation from this specification and associated LLNL drawings is required.

Table 3 Documentation Requirements

Submittal	Section	LLNL Approval	Time
Cleaning Procedures	5.1.2	Required	Before Cleaning
Handling Procedures	6.1.2	Required	Before Handling
Final Acceptance Inspection Records	7.3		Upon Request
Packing & Shipping Procedure	8.2	Required	Before Packing & Shipping

SPECIFICATION

University of California
Lawrence Livermore National Laboratory

Engineering Department
Applied Engineering Infrastructure Division

Title: **Welding of Stainless Steel Components for use in an Ultrahigh Vacuum Environment**	Author: Patrick Duffy	Date: 3-28-07
	Reviewer: Stewart Shen	Date: 3/28/07
	Approved: Donn McMahon	Date: 4/2/07

Revision History
AA – Initial Release

1. Scope

1.1. This specification defines procedures for controlling the quality of material to be used and the welds to be made on stainless steel components intended for Ultrahigh Vacuum (UHV) applications. Extreme care is required to obtain clean components that will not introduce contamination at the end-use facility. This specification is applicable to the welding of austenitic, chromium-nickel steels (ASTM 300 series) using gas metal arc welding (GMAW) and/or gas tungsten arc welding (GTAW) processes. This is a general specification and not all sections will necessarily apply to all drawings which refer to this specification.

2. Reference Documents

2.1. Unless otherwise specified, the latest revision of referenced documents is to be used. Any conflicts between this specification and the referenced documents shall be brought to the attention of LLNL in writing, for resolution, before any action is taken by the vendor.

- 2.1.1. American Society of Mechanical Engineers (ASME)
  - 2.1.1.1. ASME-BPVC Boiler and Pressure Vessel Code, Section VIII Rules for Construction of Pressure Vessels, Section IX Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operations.
- 2.1.2. American Welding Society (AWS)
  - 2.1.2.1. AWS A2.4 Standard Symbols for Welding, Brazing and Nondestructive Examination
  - 2.1.2.2. AWS A4.2M:2006 (ISO 8249:2000 Mod) Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic and Duplex Ferritic-Austenitic Stainless Steel Weld Metal
  - 2.1.2.3. AWS A5.9 Specification for Bare Stainless Steel Welding Electrodes and Rods
  - 2.1.2.4. AWS A5.12 Specification for Tungsten and Tungsten-Alloy Electrodes for Arc Welding and Cutting
- 2.1.3. American Society for Testing and Materials (ASTM)
  - 2.1.3.1. ASTM A380 Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

2.2. Mechanical Engineering Livermore (MEL) Specifications

- 2.2.1. MEL07-500002 Fabrication, Cleaning, and Assembly/Handling of Components for use in an Ultrahigh Vacuum Environment

3. **Welding Requirements**
   - 3.1. Welding shall be in accordance with the LLNL drawings, and applicable specifications.
   - 3.2. Unless supplied by LLNL, all material shall conform to the requirements stated on the drawing(s) or an appropriate ASTM Standard(s).
   - 3.3. All welding shall be performed in a **CLEAN AREA** per the Handling Requirements in MEL07-500002, Section 6.
   - 3.4. Weld procedures shall be selected to control distortion within dimensional limits allowed by the LLNL drawing(s). Distortion of flange faces, for example, shall not exceed tolerances specified on the LLNL drawing(s).
   - 3.5. All welds shall be protected by a certified, high-purity gas on both sides of the joint. Use argon for the welding gas and LN_2 boil-off nitrogen for the purge gas.
   - 3.6. All welding shall be done by qualified welders who have demonstrated the ability to make sound welds of the same type and position using the same materials and equipment. The vendor shall submit a report indicating that the welder is qualified per Section IX of the ASME Code, if required by LLNL.
   - 3.7. The weld joint shall be prepared per the Fabrication Requirements in MEL07-500002, Section 3.
     - 3.7.1. The surface or "skin" of the weld on the vacuum side of the joint shall not be broken or machined unless specified on the drawing(s) or the purchase order.
   - 3.8. Filler metal and electrodes shall be selected in accordance with and shall conform to AWS A5.9 and AWS A5.12, respectively.
   - 3.9. Only factory-sealed electrode and filler rod/wire packages are to be used in the **CLEAN AREA**. Once the package is opened, it must remain within the **CLEAN AREA** and be stored in a clean-room-quality bag to protect it from oil and other contaminants. Immediately prior to welding, clean the filler rod/wire using lint-free tissue and high-grade ethanol (190 proof ethyl alcohol).
4. **Furnace Process Requirements**
   - 4.1. Unless otherwise specified, furnace firing for stress relieving, annealing, brazing, clean firing or any other furnace process shall be performed in a hydrogen or inert atmosphere. Refer to LLNL drawings for specific process requirements and temperature ranges.
   - 4.2. When vacuum furnaces are required for an operation, the furnace must be hydrocarbon-free and may be used only with prior approval of LLNL. Refer to LLNL drawings for specific process requirements and temperature ranges.
5. **Inspection and Testing Requirements**
   - 5.1. The vendor shall be responsible for inspection and testing to assure that the product delivered conforms to requirements on the drawings, purchase order, and this specification.
   - 5.2. Prior to award of the contract, the vendor's facilities and capabilities may be subject to an inspection by an LLNL representative(s) to verify adequacy for performing work per this specification.
   - 5.3. All parts delivered shall be inspected by LLNL for compliance with this specification and the documents referenced herein. Upon request, all records of material acquisition, manufacturing, and Quality Assurance (QA) shall be made available to LLNL.
6. **Shipping and Delivery Requirements**
   - 6.1. All components are to be prepared and handled in accordance with MEL07-500002, Section 8.
7. **Documentation Requirements**
   - 7.1. The vendor shall furnish the following documentation for LLNL approval or information, in accordance with the referenced sections of this specification, at the times shown in Table 1. LLNL review of drawings, data, specifications, or procedures submitted by the vendor does not constitute acceptance of any design, materials, process, or components which do not fulfill the requirements of this specification. Written permission to the vendor prior to any change or deviation from this specification and associated LLNL drawings is required.

Table 1 Documentation Requirements

Submittal	Section	LLNL Approval	Time
Welder Qualification	3.6	Upon Request	Prior to Welding
Final Acceptance Inspection Records	5.3		Upon Request

MEL07-500004-AA

AAN07-100023-AA

SPECIFICATION

University of California
Lawrence Livermore National Laboratory

Engineering Department
Applied Engineering Infrastructure Division

Title: **Chemical Cleaning of 300 Series Stainless Steel for use in an Ultrahigh Vacuum Environment**	Author: Patrick Duffy	Date: 3-28-07
	Reviewer: Stewart Shen	Date: 3/28/07
	Approved: Donn McMahon	Date: 4/2/07

Revision History
AA – Initial Release

Caution The chemicals used in this process are solvents, acidic, and alkaline. Exercise caution in their use. Do not breathe vapors. Avoid contact with skin, eyes, and clothing by using appropriate safety equipment. Provide adequate ventilation. Carefully read and observe cautionary and first-aid information in MSDS documents.

1. **Scope**
   1.1. This document describes the procedure for chemical cleaning of 300 series stainless steel and all new-purchased flanges. Flanges with a knife edge should not be put through step 5
2. **Reference Documents**
   2.1. ASTM B 479-06 Standard Specification for Annealed Aluminum and Aluminum-Alloy Foil for Flexible Barrier, Food Contact, and Other Applications
3. **Definition of Terms**
   3.1. The Baumé (Bé) scale is a measure of a solution's specific gravity, not its concentration. For liquids heavier than water at 60° F, use the following formula to convert degrees Baumé (°Bé) heavy to specific gravity.
      3.1.1. specific gravity = 145/(145 - °Bé heavy)
4. **Chemical Cleaning Sequence**

Step 1 Vapor degrease in tetrachloroethylene or equivalent degreaser for 5 minutes.
Note: To reduce solvent concentration in the breathing zone, the work load/parts should be lowered and removed at a slow speed.

Step 2 Cold running tap water rinse for 1 minute

Step 3 Alkaline soak clean using Enprep 146[1] for 5 minutes at 180° F

Step 4 Cold running tap water rinse for 2 minutes

[1] Enprep 146, product of Enthone Inc., West Haven, CT

Step 5 Immerse in stainless steel pickle for 2 minutes consisting of:

Prepalloy[2]	1 pound
Nitric Acid, 42°Bé heavy	25% by volume
Water to make	1 gallon
Temperature	Room to 100° F
Time	Until part is free from scale and oxide

Note: Do not put knife-edged flanges in this solution.

Step 6 Cold running tap water rinse for 2 minutes

Step 7 Alkaline soak clean using Enprep 146 for 5 minutes at 180° F.

Step 8 Cold running tap water rinse for 2 minutes

Step 9 Immerse in nitric acid (30% by volume) for 2 minutes at room temperature

Step 10 Cold running tap water rinse for 2 minutes

Step 11 Immerse in Metex M-629[3] acid dip for 30 seconds at room temperature

Step 12 Cold running tap water rinse for 2 minutes

Step 13 Cold deionized water[4] rinse for 2minutes (minimum resistivity 1,000,000 ohms-cm)

Step 14 Hot deionized water (145°-150° F) rinse for 2 minutes (minimum resistivity of 1,000,000 ohms-cm)

Step 15 Immerse in analytical reagent grade isopropyl alcohol at 115° F for 30 seconds.
Note: To avoid breathing the vapors, remove the parts slowly and drain thoroughly.

Step 16 Blow dry with a dry nitrogen blast

Step 17 Dry in an air oven at 150° F

Step 18 Check for smut (particulate surface residue) before wrapping in lint-free paper. If smut is found on a mill-finish surface (an un-machined surface of the raw, stock material), consider bead blasting the surface and repeat the entire cleaning procedure. If smut is still found, or if found on a machined surface, reject the part.

Step 19 Wrap in lint-free paper and UHV aluminum foil[5] (meets ASTM B-479 "Dry Annealed, A")

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[2] Prepalloy 2201033-0050-5000, product of Atotech USA Inc., Rock Hill, SC. Dry fluoride salt substitute for hydrofluoric acid.
[3] Metex M-629, product of MacDermid Americas, Waterbury, CT
[4] Cold deionized water has a temperature of cold tap water
[5] Product of All-Foils, Inc., Cleveland, OH

MEL07-500005-AA

AAN07-100024-AA

SPECIFICATION

University of California
Lawrence Livermore National Laboratory

Engineering Department
Applied Engineering Infrastructure Division

Title: **Chemical Cleaning of Aluminum for use in an Ultrahigh Vacuum Environment**	Author: Patrick Duffy	Date: 3-28-07
	Reviewer: Stewart Shen	Date: 3/28/07
	Approved: Donn McMahon	Date: 4/2/07

Revision History
AA – Initial Release

Caution The chemicals used in this process are solvents, acidic, and alkaline. Exercise caution in their use. Do not breathe vapors. Avoid contact with skin, eyes, and clothing by using appropriate safety equipment. Provide adequate ventilation. Carefully read and observe cautionary and first-aid information in MSDS documents.

1. **Scope**
   1.1. This document describes the procedure used for the chemical cleaning of aluminum.
2. **Reference Documents**
   2.1. ASTM B 479-06 Standard Specification for Annealed Aluminum and Aluminum-Alloy Foil for Flexible Barrier, Food Contact, and Other Applications
3. **Chemical Cleaning Sequence**

Step 1 Vapor degrease in tetrachloroethylene or equivalent degreaser for 5 minutes.
Note: To reduce solvent concentration in the breathing zone, the work load/parts should be lowered and removed at a slow speed.

Step 2 Soak in Isoprep 49L[1] cleaner at 140-160° F for 5 minutes

Step 3 Cold tap water rinse for 2minutes. If water breaks appear, repeat step 2

Step 4 Deoxidize in air agitated Chem Alum Deox 350[2] desmutter and deoxidizer at 70-72° F until all oxide is removed

Step 5 Cold tap water rinse for 2 minutes

Step 6 Etch in Aluminum Etchant 33[3] at 140° F for 1-10minutes, depending on the depth of etch required

Step 7 Cold tap water rinse for 2 minutes

Step 8 Desmut in Chem Alum Deox 350 desmutter and deoxidizer (step 4) until the surface is clean

Step 9 Cold tap water rinse for 2 minutes

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[1] Isoprep 49L, product of MacDermid Americas, Waterbury, CT
[2] Chem Alum Deox 350, product of Heatbath Corp., Indian Orchard, MA
[3] Aluminum Etchant 33, product of Henkel Surface Technologies, Madison Heights, MI

Step 10 Cold deionized water[4] rinse for 2 minutes (minimum resistivity of 1,000,000 ohms-cm)

Step 11 Hot deionized water (145°-150° F) rinse for 2 minutes (minimum resistivity of 1,000,000 ohms-cm)

Step 12 For small parts, immerse in analytical reagent grade isopropyl alcohol at 115° F for 30 seconds.
Note: To avoid breathing the vapors, remove the parts slowly and drain thoroughly.

Step 13 Blow dry with a dry nitrogen blast

Step 14 Dry in an air oven at 150° F

Step 15 Wrap in lint-free paper and UHV aluminum foil[5] (meets ASTM B-479 "Dry Annealed, A")
Note: All rinses should be running and, if possible, agitated with air from a low-pressure blower. Do not use compressed air

[4] Cold deionized water has a temperature of cold tap water
[5] Product of All-Foils, Inc., Cleveland, OH

SPECIFICATION

University of California
Lawrence Livermore National Laboratory

Engineering Department
Applied Engineering Infrastructure Division

Title: **Chemical Cleaning OFE Copper for use in an Ultrahigh Vacuum Environment**	Author: Patrick Duffy	Date: 3-28-07
	Reviewer: Stewart Shen	Date: 3/28/07
	Approved: Donn McMahon	Date: 4/2/07

Revision History
AA – Initial Release

Caution The chemicals used in this process are solvents, acidic, and alkaline. Exercise caution in their use. Do not breathe vapors. Avoid contact with skin, eyes, and clothing by using appropriate safety equipment. Provide adequate ventilation. Carefully read and observe cautionary and first-aid information in MSDS documents.

1. **Scope**
   1.1. This document describes the chemical cleaning procedure for oxygen free electronic (OFE) copper for use in vacuum and brazing processes. This process will remove a nominal amount of copper from the surface
2. **Reference Documents**
   2.1. ASTM B 479-06 Standard Specification for Annealed Aluminum and Aluminum-Alloy Foil for Flexible Barrier, Food Contact, and Other Applications
3. **Definition of Terms**
   3.1. The Baumé (Bé) scale is a measure of a solution's specific gravity, not its concentration. For liquids heavier than water at 60° F, use the following formula to convert degrees Baumé (°Bé) heavy to specific gravity.
   3.1.1. specific gravity = 145/(145 - °Bé heavy)
4. **Chemical Cleaning Sequence**

Step 1 Vapor degrease in tetrachloroethylene or equivalent degreaser for 5 minutes
Note: To reduce solvent concentration in the breathing zone, the work load/parts should be lowered and removed at a slow speed

Step 2 Alkaline soak clean in Enprep 146[1] for 5 minutes at 180° F

Step 3 Cold tap water rinse for 2 minutes

Step 4 Immerse in 50% hydrochloric acid at room temperature for 1 minute

Step 5 Cold tap water rinse for 2 minutes

[1] Enprep 146, product of Enthone Inc., West Haven, CT

Step 6 Immerse in the following solution for a maximum of 1 minute, depending on the surface finish required:

Phosphoric Acid, 75%	21 gallons
Nitric Acid, 42°Bé heavy	7 gallons
Acetic Acid, glacial	2 gallons
Hydrochloric Acid, 20°Bé heavy	19.2 fluid ounces
Temperature	Room

Step 7 Cold tap water rinse for minimum of 2 minutes until the film on part disappears

Step 8 Immerse in the following solution until the part is covered with white film (do not immerse part for more than 5 seconds):

Sulfuric Acid, 66°Bé heavy	13 gallons
Nitric Acid, 42°Bé heavy	7 gallons
Water	10 gallons
Hydrochloric Acid, 20°Bé heavy	15 fluid ounces
Temperature	Room

Step 9 Cold tap water rinse for minimum of 2 minutes until the film on part disappears

Step 10 Cold deionized water[2] rinse for 1 minute (minimum resistivity of 1,000,000 ohms-cm)

Step 11 Hot deionized water (145°-150° F) rinse for 30 seconds (minimum resistivity of 1,000,000 ohms-cm)

Step 12 Immerse in analytical reagent grade isopropyl alcohol at 115° F for 30 seconds
Note: To avoid breathing the vapors, remove the parts slowly and drain thoroughly

Step 13 Blow dry with a dry nitrogen blast

Step 14 Dry in an air oven at 150° F

Step 15 Wrap in lint-free paper and UHV aluminum foil[3] (meets ASTM B-479 "Dry Annealed, A")

[2] Cold deionized water has a temperature of cold tap water
[3] Product of All-Foils, Inc., Cleveland, OH

MEL07-500007-AA

AAN07-100026-AA

SPECIFICATION

University of California
Lawrence Livermore National Laboratory

Engineering Department
Applied Engineering Infrastructure Division

Title: **Chemical Etching of Titanium for use in an Ultrahigh Vacuum Environment**	Author: Patrick Duffy	Date: 3-28-07
	Reviewer: Stewart Shen	Date: 3/28/07
	Approved: Donn McMahon	Date: 4/2/07

Revision History
AA – Initial Release

Caution The chemicals used in this process are solvents, acidic, and alkaline. Exercise caution in their use. Do not breathe vapors. Avoid contact with skin, eyes, and clothing by using appropriate safety equipment. Provide adequate ventilation. Carefully read and observe cautionary and first-aid information in MSDS documents.

1. **Scope**
   1.1. This document describes the chemical etching procedure for titanium. This process will remove a heavy amount of titanium from the surface.
2. **Reference Documents**
   2.1. ASTM B 479-06 Standard Specification for Annealed Aluminum and Aluminum-Alloy Foil for Flexible Barrier, Food Contact, and Other Applications
3. **Chemical Etching Sequence**

Step 1 Vapor degrease in tetrachloroethylene or equivalent degreaser for 5 minutes
Note: To reduce solvent concentration in the breathing zone, the work load/parts should be lowered and removed at a slow speed.

Step 2 Alkaline soak clean using Enprep 146[1] for 5 minutes at 180° F

Step 3 Cold tap water rinse for 2 minutes

Step 4 Immerse in acetic acid - hydrofluoric acid dip:

Glacial Acetic Acid	895 milliliters
Hydrofluoric Acid, 48%	135 milliliters
Deionized Water to make	4000 milliliters
Temperature	Room

Step 5 Cold tap water rinse for 1 minute

Step 6 Cold deionized water[2] rinse for 1 minute (minimum resistivity of 1,000,000 ohms-cm)

Step 7 Hot deionized water (145°-150° F) rinse for 30 seconds (minimum resistivity of 1,000,000 ohms-cm)

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[1] Enprep 146, product of Enthone Inc., West Haven, CT
[2] Cold deionized water has a temperature of cold tap water

Step 8 Immerse in analytical reagent grade **isopropyl alcohol** at 115° F for 30 seconds
Note: To avoid breathing the vapors, remove parts slowly and drain thoroughly.

Step 9 Blow dry with dry nitrogen blast

Step 10 Dry in an air oven at 150° F

Step 11 Wrap in lint-free paper and UHV aluminum foil[3] (meets ASTM B-479 "Dry Annealed, A")

[3] Product of All-Foils, Inc., Cleveland, OH